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(71) Applicant (*for all designated States except US*): AUTOMOTIVE DEVELOPMENT SPECIALISTS LTD. [GB/GB]; 90–92 King Edward Road, Nuneaton, Warwickshire CV11 4BB (GB).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): PIPER, Andy [GB/GB]; Oakley Wood Farmhouse, Oakley Wood, Banbury Road, Leamington Spa, Warwickshire (GB). GOODALL, Chris [GB/SE]; Keflaviksvegen 19, S-461 73 Throllhättan (SE).

(74) Agents: SUÈR, Steven, Johannes et al.; Ablett & Stebbing, Caparo House, 101–103 Baker Street, London W1M 1FD (GB).

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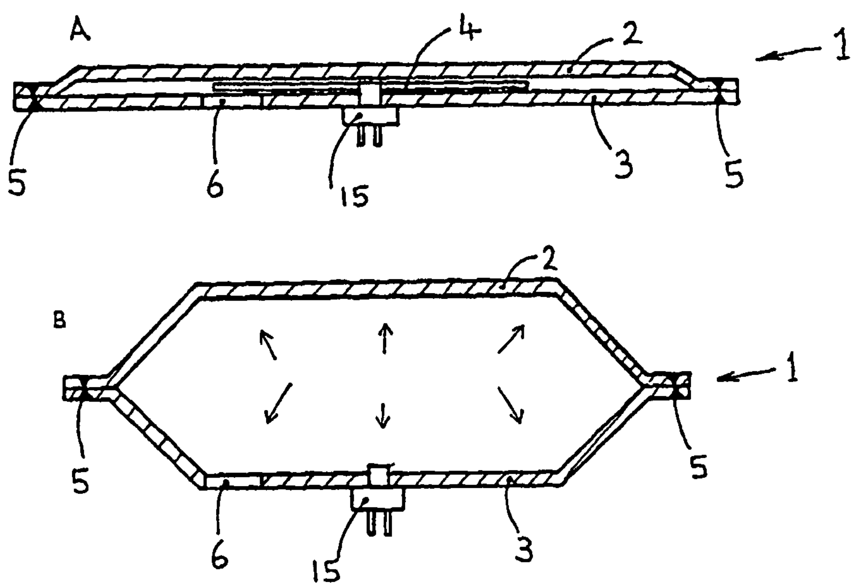



(57) Abstract

The present invention concerns an inflatable enclosure (1) for affording occupant protection within a vehicle. The enclosure has deformable walls (2, 1) which hold a deformed configuration when the enclosure is inflated.

# INFLATABLE PROTECTION APPARATUS

The present invention relates to inflatable protection apparatus and more particularly to such apparatus when disposed within a vehicle.

In this connection, fabric air bags are well known for providing impact protection to the occupants of a vehicle in the event of a sharp deceleration of the vehicle, for example as a result of a collision.

More recently, there has been a proposal for an air bag assembly where the air bag takes the form of an inflatable metal bladder. Such a proposal is disclosed in WO96/22199 [Olin Corporation] and is directed to such a bladder connected via a conduit to a discrete gas generator. The advantage of such a metal bladder arrangement is discussed as relating to the availability of being able to use toxic and relatively hot inflation gases, the bladder being a sealed unit which is unlikely to puncture and which, because of its metal components will readily dissipate the heat of the inflation gases without likely harmful effects to the vehicle occupants.

However, the arrangement of WO96/22199 has certain disadvantages. In particular, because the bladder is a sealed unit, it can in practice only offer limited energy dissipation. In this regard, the only effective means for energy dissipation is through deformation of the metal skin of the bladder, such deformation being restricted in WO96/22199 as the inflated bladder has, at relevant moment, trapped therein a quantity of gas which is difficult to compress in the time-frames involved in a collision.

Since the known bladder will tend to resist rapid compression and thus deformation, its characteristics in energy dissipation are seriously hampered.

A further disadvantage of WO96/22199 concerns its use of a separate gas generator for providing the inflation gases. The necessity of a separate generator and associated conduiting between the generator and the bladder places severe limitations on the siting of the apparatus components. The use of such ancillary components add to the space taken up by the apparatus, its weight and its production costs.

Accordingly, it is an object of the present invention to alleviate the problems associated with such known apparatus.

According to a first aspect of the present invention there is provided an inflatable assembly for use in impact protection, the assembly comprising:- a deformable enclosure having provided therein a gas generant; wherein the enclosure is formed of material whereby it retains a deformed configuration following activation of the generant.

The provision of a gas generant within the enclosure greatly widens the siting possibilities of the assembly over known arrangements. It also obviates the weight and production costs that would be involved in separate gas generation means. In preferred embodiments, the gas generant is a gas propellant.

Preferably, the enclosure comprises said gas generant, sandwiched between a pair of deformable sheets, the enclosure having a substantially flat laminar configuration in an uninflated state. Of course, the enclosure may in alternative

configurations be other than flat or laminar where, for example, there are not space constraints or where a non flat or non laminar configuration is advantageous.

Conveniently, the enclosure is provided with one or more vents. Such vents allow the enclosure to deform effectively when subjected to an impact following inflation. The ability of the enclosure to dissipate energy relates to its ability to deform and to dispel gas through the vents.

Preferably, one or more of said enclosures are positioned in the side structure of a vehicle, the one or more enclosures being configured on deployment to expand generally outwardly, away from the interior of the vehicle. With such an arrangement, protection of the vehicle's occupants is enhanced since the one or more enclosures act to engage any side intrusions before they can reach the occupants.

In preferred embodiments, one or more of said enclosures are positioned within the side structure of a vehicle, level with the area of the pelvis of any occupant within the vehicle. In this connection, the pelvis can tolerate comparatively high forces and is proficient at causing the remainder of the body to move therewith on an impulse thereto. Hence any impact which reaches the occupant's body will be concentrated on the pelvis area, moving the pelvis and hence as a result the less tolerant areas of the body away from danger.

Conveniently, one or more of said enclosures are positioned within the side structure of a vehicle, level with the area of the shoulder of any occupant within the vehicle. Of the areas of the body, the shoulder can also tolerate relatively high forces such that the one or more enclosures can be sited

at shoulder height as well as or instead of in the area of the pelvis.

In preferred embodiments, one or more of said enclosures are provided at or adjacent the knee area of an occupant.

Preferably, one or more of said enclosures are provided between a cross car beam or vehicle structure and a steering column of a vehicle. Such an arrangement provides for a controlled crash management of the steering column of a vehicle.

In preferred embodiments, one or more of said enclosures are provided within the lower seat structure of a vehicle, below an occupant's thigh area. In this manner, the propensity of an occupant to submarine can be reduced and the kinematics and loading of said occupant can be controlled.

Conveniently, one or more of said enclosures are provided within or adjacent the bonnet structure of a vehicle. Such an arrangement affords pedestrians with enhanced impact protection.

Preferably, one or more of said enclosures are provided with vents for supplying inflation gases to an associated flexible walled chamber. With a combined enclosure and flexible walled chamber, e.g. in the form of an air bag, such an arrangement can afford primary air bag impact protection, followed by secondary enclosure protection in the event of an impact after the air bag has deflated. The enclosure can further dissipate heat energy from the propellant gases, such that they do not damage the material of the air bag or injure the vehicle occupant.

In preferred embodiments, one or more of said enclosures are provided within an aircraft bulkhead structure. With such an arrangement, a space efficient impact dissipation means can be deployed in the likelihood of a crash, the self supporting nature of the enclosure material meaning that the protection is not lost due to deflation, for example if the enclosure is inflated well in advance of a crash.

Conveniently, one or more of said enclosures are provided within the roof or upper body structure of a vehicle. In this manner, high sided and cabriolet vehicles have enhanced protection in the event of a roll-over.

One or more enclosures may moreover be provided in the floor pan structure of a vehicle at or adjacent an occupant's foot area to thereby move the occupant's lower leg away from risk of injury on deployment of the enclosure.

Preferably, one or more of said enclosures are provided within a rim structure of a vehicle steering wheel. With such an arrangement, the rim of the steering wheel can be enlarged in the event of an accident, such that it present a larger surface area against which an air bag can react.

In preferred embodiments, one or more of said enclosures are provided within an engine compartment of a vehicle. Enclosures positioned in the engine compartment can be used to fill in air gaps normally present to thereby limit localised intrusion into the passenger compartment and afford local strengthening and energy dissipation to deter engine components accelerating rapidly towards the bulkhead.

Conveniently, one or more of said enclosures are provided as

a shut-off valve within a conduit. By inflating an appropriately shaped enclosure positioned within a conduit, the flow of material through that conduit can be permanently occluded or shut-off.

Preferably, one or more of said enclosures are provided as an electrical cut-off switch. By configuring part of an enclosure into an electrical contact, the movement resulting from inflation thereof can be used to permanently break a connection which that contact has with another contact.

In preferred embodiments, one or more of said enclosures are provided as inflatable load bearing beam structures. Undeployed and hence space efficient enclosures can be transported to where they are required and then inflated to provide instant load bearing rigid beam structures.

Conveniently, one or more of said enclosures are provided as deformation simulation means within a static or dynamic crash simulation rig. By careful use of enclosures in a crash rig, a crash simulation can be arranged without the need for actual movement of the crash rig itself. In this manner, the crash simulation can be performed with greater accuracy and at reduced expense.

Preferably, one or more of said enclosures are provided as an inflatable buoyancy means. By inflation of an enclosure, an instant buoyancy means can be provided where required.

According to a second aspect of the present invention there is provided an inflatable assembly for use in impact protection, the assembly comprising:-

a deformable enclosure;

means for inflating the enclosure to deform it;
wherein the material of the enclosure is such as to retain an inflated configuration following its inflation, and further wherein the enclosure is provided with one or more vents for enhancing any subsequent deformation of the inflated enclosure.

Preferably the one or more vents are provided with a pressure sensitive valve. The valve may in its simplest form take the form of a foil over the vent which opens when a certain pressure in the enclosure is reached.

The one or more vents may be provided as discontinuities in the seal or join between component parts of the enclosure.

In preferred embodiments, the one or more vents may comprise frangible sections in the enclosure, for example a weakened part of the enclosure wall.

The one or more vents may comprise ducting to remove generant gases from the locality of the enclosure. This can be important in for example heat sensitive areas.

Preferably, the one or more vents is plugged, in an undeployed state of the enclosure, by a component of the enclosure which on deployment of the enclosure is urged from the vent to allow venting.

The enclosure may have serpentine configuration in the undeployed state in order to delay the timing of venting.

Examples of the present invention will now be described with reference to the accompanying drawings, of which:-

Figures 1a and 1b show cross-sectional views of an inflatable assembly of a first embodiment of the present invention;

Figures 2a and 2b show part cross-sectional views of the inflatable assembly in a second embodiment;

Figures 3a and 3b show schematic views of the inflatable assembly in a third embodiment;

Figures 4a and 4b show part cut-away views of the inflatable assembly in a fourth embodiment;

Figures 5a and 5b show part cross-sectional views of the inflatable assembly in a fifth embodiment;

Figures 6a and 6b show cross-sectional plan views of the inflatable assembly in a sixth embodiment;

Figures 7a and 7b show cross-sectional views of the inflatable assembly in a seventh embodiment.

Figure 8 shows a schematic view of the inflatable assembly in an eighth embodiment;

Figure 9 shows a schematic view of the inflatable assembly in a ninth embodiment;

Figures 10a and 10b show part cross-sectional views of the inflatable assembly in a tenth embodiment;

Figure 11 shows a plan view of the inflatable assembly in an eleventh embodiment;

Figures 12a and 12b show part cross-sectional views of the inflatable assembly in an twelfth embodiment;

Figures 13a and 13b show part cross-sectional views of the inflatable assembly in a thirteenth embodiment;

Figures 14a and 14b show part cross-sectional views of the inflatable assembly in a fourteenth embodiment;

Figures 15a to 15d show part cross-sectional views of the inflatable assembly in a fifteenth embodiment;

Figures 16a and 16b show part cross-sectional views of the inflatable assembly in a sixteenth embodiment; and

Figures 17a to 26 show cross-sectional and plan views of inflatable assemblies having different venting configurations.

As shown in the first embodiment of Figures 1a and 1b, the basic inflatable assembly structure 1 comprises two sheets of self supporting material 2 and 3, such as steel, which are sandwiched around a sheet of generant, for example, propellant material 4 and welded along weld lines 5 to encase the propellant and thereby form an enclosure.

Figure 1a shows an undeployed state where the propellant sheet has yet to be activated. The enclosure is in this state a flat laminar member, which can be readily sited at many locations in, for example, a vehicle. The enclosure need not however be a flat laminar member in the non deployed state, and there are instances where it may be beneficial to provide, for example, a folded enclosure to further control

the deploying shape and maximize its performance.

When required, the propellant sheet 4 is activated via a suitable initiator 15 such that the sheets 2 and 3 are forced apart rapidly, the enclosure 1 expanding to form a box like structure as shown in Figure 1b. Once expanded, the nature of the material of the sheets means that the enclosure will retain its expanded shape, that is unless the enclosure is subsequently deformed, for example due to it being used to dissipate impact energy.

Vents in the form of apertures 6 are provided in the enclosure to enable the enclosure to crumple and dispel the enclosed gas and thereby dissipate energy effectively if subjected to a deforming impact.

Turning now to more specific embodiments of the enclosure, as shown in a second embodiment of Figures 2a and 2b, the enclosure may be provided within a vehicle door or vehicle side to afford side impact protection.

As shown in Figure 2a, an enclosure 1 of the present invention is positioned within a car door structure 7. The door structure includes an outside skin 8, a window glass 9, an interior door trim 10, a sill 11 and conventional pelvis padding 12. The enclosure 1 is located within the area of conventional pelvis padding 12, taking up very little space on account of its flat nature.

In the event of a side impact, conventional industry standard pressure or acceleration/deceleration impact sensors (not shown) detect the impact and command a deployment signal to the enclosure 1. At about 10ms after the first indications of

a side impact, the enclosure is fully inflated as shown in Figure 2b, the enclosure being arranged to expand outwardly away from the interior of the car towards an intruding structure 13.

The expanding/expanded enclosure allows early coupling of the pelvis padding 12 and any intruding structure at the side of the car, the expanded enclosure filling the space in the area between the outer door skin 8 and the door trim 10. If the window glass 9 is in the path of the expanding enclosure, it will be smashed out of the way.

The pelvis padding 12 is also pushed inboard to a lesser degree towards the occupant's pelvis thereby concentrating any early loading experienced by the occupant at the pelvis area. In this respect, of the areas of the human body, the pelvis is relatively tolerant of large forces.

By virtue of this arrangement, an occupant of the car will be protected in three main respects from impacts resulting from an intruding structure at the side of the vehicle.

Firstly, the enclosure 1 moves a section of the pelvis padding outwardly to meet any intruding structure before it reaches the occupant, whilst at the same time filling and thereby strengthening any empty space within the lower door structure. The relative spacing of the occupant and any intruding structure is thus maintained.

Secondly, because of its deformable nature, the enclosure acts to dissipate impact energy imparted thereto by the intruding structure.

Thirdly, by virtue of its positioning in the lower area of the door adjacent the occupant's pelvis, any forces passed on to the occupant are concentrated at the occupant's pelvis area, which can best withstand such forces to thereby move the pelvis and hence accelerate the occupant's spine and hence remainder of the occupant inwardly, further away from the intruding structure. This arrangement reduces the likelihood of rib deflection and thus loading on the vulnerable area of the chest.

Further, with such an arrangement in the case of an inadvertent deployment of the enclosure, it will not significantly displace the interior door trim inwardly, thereby reducing the risk of injury to occupants, particularly small children who may be out of position within the vehicle interior.

Another area of the human body which can better tolerate relatively high forces is the shoulder area. Hence, although not shown, an enclosure may be provided within the door or vehicle side structure at the shoulder level of the occupant in addition to the pelvis level enclosure, or instead of it where such a pelvis level enclosure cannot be fitted.

Figures 3a and 3b show a third embodiment of the present invention where an enclosure 1 is used in relation to the management of the angle of inclination of a steering column 14 in the event of a vehicle collision.

As shown in Figure 3a, in normal conditions a steering column 14 is maintained at an angle $\propto$ of around 26° to the horizontal. In the event of a severe collision, where the steering wheel is provided with an air bag the occupant can

load the air bag to such a degree that the steering column and cross car beam 17 are displaced vertically upwardly. In such circumstances, the steering column 14 can no longer collapse correctly as designed. As a result, the steering wheel 16 can ride up the occupant, its lower rim area causing severe chest and rib injuries.

To counter such problems, an enclosure 1 is positioned between cross car beam 17 and the steering column 14. In the event of an impact, the enclosure is expanded as shown in Figure 3b such that the steering column 14 and hence steering wheel 16 are dynamically lowered to position the steering wheel most effectively for deployment of the steering wheel air bag and steering column collapsing mechanisms.

Figures 4a and 4b show a fourth embodiment of the present invention, where an enclosure 1 is positioned within the seat structure 18 of a vehicle. As shown in Figure 4a an occupant 19 of a vehicle is seated on seat structure 18. In the event of a frontal impact of the vehicle, there is a tendency for the vehicle occupant to submarine from the normal position such that the safety systems within the vehicle, i.e. seat belts and air bags, fail to operate correctly.

In order to counter this submarining of the occupant, an enclosure 1 is positioned within the lower seat structure 20 of the vehicle, below the occupant's thigh area. On sensing of an impact, the enclosure is inflated as shown in Figure 4b to present an energy dissipating structure below the occupant, which serves to counter submarining of the occupant.

Figures 5a and 5b illustrate a fifth embodiment of the

present invention directed to the knee area of the vehicle occupant 80. In this regard, knee bolsters are known to be used to provide occupant restraint by engaging with the occupant's knees during a crash event and subsequently controlling the deceleration of the occupant's lower extremities. The control of the occupant's deceleration is normally achieved by deformation in the knee bolster and surrounding structure. Typically knee bolsters are designed such that the femur load of a test dummy is controlled to be below 7kN (legal limit 10kN).

It is desirable to dissipate as much occupant crash energy as possible through the knee bolster interaction, so reducing the energy that needs to be dissipated through the more sensitive body regions such as the chest or head.

Current knee bolsters are however limited in their performance by:-

(a) Positioning. Conventional knee bolsters are located in the vehicle instrument panel. The positioning of the knee bolster is a compromise between providing enough room for ingress/egress (swinging the knees in and out of the vehicle), which tends to require the bolster to be forward in the vehicle, and providing the opportunity for early occupant engagement during a crash, which tends to require the knee bolster to be moved rearwards in the vehicle;

(b) Package space. Conventional knee bolster designs require tremendous package space in order to function correctly. The vehicle designer must consider that the knee bolster must be able to deform into a free space of

75-100 mm in a crash event. This is not always possible, especially on the driver side of the vehicle where the knee bolster is in close proximity to the steering column;

(c) Ability to Manage Energy. The conventional knee bolster is limited in its ability to effectively manage the occupant impact. The positioning of the knee bolster results in occupant impact relatively late in a crash event (approximately 50ms in a 30mph impact) by which time the occupant velocity is relatively high (typically 6-8 m/s). The knee bolster therefore has to dissipate a significant amount of energy within the limited amount of free space within the instrument panel. Conventional knee bolsters are also designed to be made of fabricated steel beams or blocks of energy absorbing foam. Neither of these designs permits the efficient square ware force deflection curve; and

(d) Conventional knee bolster designs can be very heavy and expensive as stand alone components. The cost and mass problem is added by the structure needed in the instrument panel to react the knee bolster forces.

Two main alternatives exist for active knee bolster designs, namely knee airbags and deployable knee bolsters.

Knee airbags address many of the problems with conventional knee bolster systems. In particular the knee airbag is able to start restraining the occupant's knees earlier in the event allowing more efficient energy management and controlling occupant kinematics.

However, knee airbag systems are expensive (approximately £20-40 per vehicle); they are bulky and difficult to package (needing an external inflator and a means to port gas to the cushion); they need a cushion pack volume and housing structure; and deployment timing is critical - one shot devices - if the occupant interaction is delayed for some reason, then the effectiveness of the knee airbag is severely limited.

Deployable knee bolsters also exist and systems have been conceived where the surface of the knee bolster is pushed rearwards in the vehicle in a crash event. These systems are effective in their ability to provide early occupant restraint and are robust in that they are not time sensitive. However, deployable knee bolsters tend to be expensive, heavy and difficult to package.

With the present invention as shown in Figures 5a and 5b, the knee enclosure 81 is configured to deploy both forward and rearward in the vehicle. In the deployed position, as shown in Figure 5b, the rearward deployment is intended to provide early coupling with the occupant 80. The forward deployment is intended to couple with the structure within the vehicle instrument panel to provide a reaction force to the occupant interaction and thereby enables a reduction in the amount of structuring usually needed to support conventional knee bolsters. The knee enclosure 81 also allows for coverage of normally unprotected areas such as steering column adjustment levers.

The use of the enclosure in this manner provides the following opportunities:

The small required package space can be integrated within the normal knee bolster trim, glove box lid or back of the front seat (for rear seat occupants); light weight - the knee enclosure itself would typically weigh less than 0.5kg. This is a lower mass than conventional knee airbag systems. Further, mass saving can be achieved by removing the structure that is normally included to support conventional knee bolsters; robust - once deployed the knee enclosure will assume a stable structural volume, available to dissipate occupant impact energy for extended durations (not time sensitive as with the knee airbags); and low cost - knee enclosures are significantly lower cost than the knee airbag due in part to the integration of the gas generant into the can.

In a sixth embodiment, an enclosure 1 is positioned within a bonnet structure of a vehicle as shown in Figure 6b.

In this connection, impending European legislation requires that vehicles be assessed for their potential to injure pedestrians. In order to meet stringent head injury criteria, vehicles need 40-80mm of space between a vehicle bonnet and any hard areas beneath the bonnet, such as suspension turrets 21 or engine cylinder heads as shown in Figure 5a. This spacing is considered to give a sufficient degree of safety for a head impact 22 on the bonnet.

The necessity of such spacing places severe constraints on vehicle design in terms of styling, both for aesthetic and aerodynamic criteria.

In Figure 6b, there is shown the sixth embodiment where an enclosure 1 is provided between inner and outer skins 24; 25

of bonnet 23 such that in the event of a pedestrian impact being sensed, the enclosure is inflated to expand the bonnet volume and thereby create the required spacing. At the same time an energy dissipating area is developed to lessen the likely injuries to the pedestrian. The pedestrian impact/proximity can be sensed by radar or other suitable pre-impact sensing technologies. The inflation time of the enclosure is typically 10-30 ms. If the pedestrian strikes the expanded bonnet, the enclosure can deform in a relatively controlled manner to dissipate the impact energy.

The enclosure could be arranged to cover the whole bonnet area or to cover specific 'hard' areas under the bonnet.

In a seventh embodiment of the present invention, the enclosure 1 may be used in conjunction with additional flexible membrane chambers to form multi-chambered arrangements as illustrated in Figures 7a and 7b.

In this connection, Figure 7a shows a section of vehicle instrument panel 26 in cross-sectional view incorporating an enclosure 1 which is coupled to a more conventional air bag 27. In this regard, conventional airbags maintained within the instrument panel have the following challenges:-

(a) Insufficient deployment of the Passenger Airbag through the Instrument Panel. In this regard, with a conventional airbag as the airbag cushion inflates and tries to force open the airbag module protective cover and subsequently the instrument panel or deployment door, the pressure needed to open the deployment door causes large back pressure which leads to airbag cushion mechanical and thermal stress. This issue is further complicated by the design of the instrument

panel tear split line which needs to be strong enough to withstand every day customer use whilst being weak enough to allow timely splitting for airbag cushion unfolding.

As a consequence, high thermal and mechanical stresses on the airbag cushion drives cushion cost/weight. Also inefficient deployment necessitates the use of more powerful, heavier inflators and inefficient deployment slows the airbag positioning which can compromise safety performance. Further, pressure build up results in high "punch" out forces when the cushion pushes through the instrument panel. These high "punch" out forces represent a significant risk of injury to occupants positioned close to the instrument panel.

(b) Inconsistency of instrument panel door opening and consequential inefficient instrument panel design. During the first milliseconds of an airbag deployment, the flow of gas through the airbag cushion is very difficult to control. This results in a lack of consistency of the pressure distribution of the airbag onto the instrument panel inner surface. This, in turn tends to cause global displacement of the deployment door rather than the preferred concentrated loading along the split line. With concentrated loading, it is possible to open the door split line quickly without overloading the deployment door hinge lines. Without this control, it is necessary to increase the strength of the hinge line, increasing the stiffness and further delaying the airbag unfolding process. Also, when the instrument panel deployment door is globally loaded, then its surface skin/foil tends to be elongated over the entire surface. Since this skin/foil must be elastic to allow the instrument panel production techniques, it can be difficult to induce tearing of the instrument panel skin.

As a consequence, global elongation of the instrument panel skin/foil before splitting causes a build up of pressure within the airbag cushion which results in the "punch" out characteristic described above. This leads to an increased risk of injury to the occupants close to the instrument panel. Further, there is an increased risk of fragmentation of the deployment door and/or instrument panel skin and high thermal and mechanical stresses on the airbag cushion drives cushion cost/weight. Inefficient deployment necessitates the use of more powerful heavier inflators and inefficient deployment slows the airbag positioning which can comprise safety performance. Delayed opening of the instrument panel cover increases the severity of bell mouthing, where the sidewalls of the airbag module are deformed due to over pressurisation. This drives cost and weight for the airbag module.

Finally, delayed opening of the instrument panel cover also results in partial deployment of the cushion within the module. This partial unfolding means that the airbag engineer is restricted in using the airbag fold to control the cushion kinematics.

(c) It is not always possible to position the airbag module in an ideal position to assure airbag deployment positioning. Packaging of vehicle interiors tends to result in the airbag module being positioned in a non-ideal orientation. It can therefore be difficult to control the actual unfolding of the airbag and the subsequent positioning relative to the occupant. This concern is particularly prevalent to the use of so called "top mount" airbags. This positioning concern is a particularly topical issue at present with the introduction of vehicle crash worthiness legislation for the

small female occupant sat in the fully forward seat position (fmvss 208 NPRM).

As a consequence, it is sometimes necessary to compromise airbag performance due to package restrictions and there is a risk of non-comfortable positioning the airbag for the small adult occupant sat in the fully forward seat position (particularly for the top mount passenger airbag concept).

(d) How to make the passenger airbag system impact effective for secondary events? Deployment of typical passenger airbags takes approximately 50ms. Within 150ms the airbag becomes very soft and would provide little protection in the event of a further vehicle deceleration. Normally the airbag engineer would try to design the deployment door to self close after the event in an attempt to minimize the injury risk in the case of head impact. This can provide a difficult challenge and can drive the design cost of the instrument panel.

As a consequence, there is an increased cost implication on the instrument panel and if the instrument panel door fails to self-close then there is a risk of occupant impact/injury/burning.

With the present invention as shown in Figure 7a, the enclosure (1) is positioned/attached to an output area of the airbag inflator (y) and located within the cushion pack volume of the airbag module.

When the inflator is triggered then gas flows from the inflator, through the manifold system and into the enclosure (1). The enclosure tends to deform as the pressure within

the enclosure is greater than that in the airbag cushion. The enclosure is accelerated toward the instrument panel deployment door splitline (z). The enclosure strikes the deployment door (either directly or indirectly through the cushion pack) and causes early tearing of the splitline/skin/foil. Whilst this process is ongoing, some gas is permitted to enter the airbag cushion through the enclosure vent holes (28). This serves to inflate the cushion in a traditional way. With the deployment door open, gas is free to flow through the various enclosure vents, and sideways through the open ends of the enclosure and fill the airbag cushion in a controlled manner. Positioning of the enclosure vent holes also permits the directing of the airbag unfolding by use of the "jetting" effect.

Alternatively the enclosure can be used to direct gas flow/cushion, mass toward the instrument panel splitline to promote efficient opening of the deployment doors. The closure may be manufactured of any formable material. Preferably the enclosure is relatively rigid in form to allow for control of the enclosure position relative to the airbag cushion which must be folded around the enclosure.

Preferably the enclosure is however made of a ductile material which would not fragment/tear under deployment. However, it could be possible to use a brittle/weak type material which could fail in a controlled manner during deployment.

Such an arrangement offers many advantages. For example, force to the instrument panel deployment door is concentrated as the enclosure is accelerated to "impact" the deployment door splitline. This provides early and controlled tearing

of the instrument panel splitline. The enclosure serves to maintain a free volume through which the inflator gas can flow during the first milliseconds of airbag deployment. This reduces mechanical and thermal stress on the airbag cushion and could lead to cost and weight reductions in the design of airbag cushions. The use of a metallic housing could also dissipate some of the heat which is evident from the first milliseconds of an inflator gas flow; the strategic placement of the enclosure vent holes allows for the airbag cushion to be positioned/directed by the use of "gas jetting" forces. This is particularly useful in assisting the positioning of the passenger airbag down onto the lower chest area of the small female occupant sat toward the front of the seat travel range; when metallic or plastic enclosures are used it is possible to use the deployed condition as a protective feature to reduce the risk of head impact injury. There is also a reduction in the risk of occupant burning from the potentially hot inflator housing. The design of instrument panel deployment doors may be simplified by using this feature; enhanced control of the airbag cushion kinematics, and/or the opening mechanism of the instrument panel door, contributes to a safer system with a potential reduced risk of injury to occupants close to the instrument panel.

The use of a deformable enclosure provides occupant protection from the airbag module in subsequent/secondary impacts. With such an arrangement, an occupant is afforded primary protection in the form of the air bag as well as secondary protection for any second subsequent impact at which time the conventional air bag may well have deflated.

The use of a pre-positioned deformable enclosure provides

improved consistency, improved crash safety performance and/or reduced risk of injury to out of position occupants.

The deployment of conventional airbag systems involves inflation of a fabric cushion at very high speeds. Real life experience has shown that front seat vehicle occupants may be injured if they are positioned within the deployment zone of an airbag when it is being inflated. These injuries are induced by a number of characteristics of the airbag including the force of the gas jet from the inflator, into the airbag cushion.

The present invention can reduce the risk of injuring occupants by diffusing and/or redirecting this gas jet and dissipating the heat from the initial gas flow. This has a significant effect in reducing inflation related forces to the vehicle occupant and so reduces the probability of injury. Careful design of the deformable enclosure can also help to open an airbag deployment panel or door in a controlled manner, again reducing the injury risk to out of position occupants.

The air bag may take the form of any suitable deformable/flexible membrane and the shapes of the enclosure and the air bag can vary considerably to suit needs. The air bag could be made from any suitable material, for example natural fabrics; woven nylon, woven polyester, plastics, wood fibre or even thin metal sheets of e.g. aluminium, copper, steel or alloys.

The enclosure 1 is further envisaged suitable for use in aircraft bulkheads as shown in the eighth embodiment of Figure 8, or in high sided vehicles for roll-over protection

as shown in the ninth embodiment of Figure 9.

In relation to Figure 8, aircraft bulkheads 29 represent a serious head and neck injury risk for front row occupants 30 in the event of a crash. Airlines have used padding and air bags to reduce this risk, although padding takes up valuable passenger space (100mm package space) in the interior of the aircraft, whilst air bags only afford protection for a short period (50ms to 5s)and hence require very precise actuation timing and sensing.

With an enclosure 1 in place, the undeployed enclosure will take up minimal space (as shown in phantom lines) and when deployed as shown in bold in Figure 8 will offer extended protection, such that aircrew could deploy the enclosure, for example prior to a potential impact, thereby doing away with complex sensing apparatus. The enclosure can be profiled to offer optimum support to the head and chest to thereby limit the risk of injury to the neck.

As shown in Figure 9, an enclosure of the present invention may be used to reduce the likelihood of injury and damage due to rollover. The problem of rollover is particularly relevant to high sided vehicles which suffer severe damage and structural deformation in rollover incidents, with related injuries to the vehicle occupants.

Together with industry standard rollover sensors, an enclosure 1 can be used to control deceleration of a vehicle in a rollover situation, thereby attenuating peak forces on the vehicle body, minimising deformation and reducing the risk of injury to the occupants. The rollover enclosure arrangement can for example be used with lorries, trucks

buses, trains, and convertible cars. Similar technology could be used on the underside of aircraft to limit damage in 'belly-flop' type incidents. Further, enclosures of the present invention can be mounted to the underside of load drops from aircraft. In the undeployed state within the aircraft, the enclosures only take up minimal space, but when inflated on being dropped from the aircraft they afford protection on impact of the load on the ground.

Further, in the tenth embodiment of Figures 10a and 10b, an enclosure of the present invention can be placed within a steering wheel rim structure 50 (shown in cross-section) to enlarge the circumference of the steering wheel rim in the event of an accident as depicted in Figure 10b, thereby assisting in the release of the hands of an occupant from the wheel, increasing the size of the reaction surface of the rim for a steering wheel air bag and allowing local deformation and hence energy dissipation.

The characteristics of the enclosure mean that it can be provided within a vehicle interior in places not previously accessible to such safety systems. In this regard, recent legislation in North America (FMVSS 201) has highlighted the need to provide head impact protection in vehicle interiors. Whilst the legislation is worthy it has presented some difficulties when positioning inflators for head protection devices such as airbags. Normally these inflators are very stiff and, without 20-30 mm of foam padding, can represent a serious risk of injury if impacted by an occupant's head. Any padding tends to intrude on vehicle interior space and can lead to unwanted compromises on the vehicle interior styling.

The present invention can help to overcome such inflator positioning constraints by providing supplementary head impact protection when deployed. For example, on deployment of an inflatable curtain, during frontal, side or roll over accidents, the deformable enclosure would expand inwards, towards the occupants head. This expanded, deformable enclosure is now positioned to protect the occupant's head from possible impact to the airbag housing/inflator hard structure. This invention will permit the installation of airbag inflators into such vehicle zones as upper A, B or C pillars, roof structures etc.

In a eleventh embodiment of the present invention as shown in Figure 11, enclosures 1 can be positioned within the engine compartment 40 of a vehicle. In this regard, engine compartments include large air volumes for cooling, noise control and engine component movement. Such air volumes are typically between cross members 41, bulkhead 42, engine 43 and engine manifold 44. They are undesirable in the event of an accident in that they reduce the overall structural strength of the engine compartment and can allow heavy engine components to accelerate quickly within the engine compartment and thereby cause greater impact damage to the bulkhead 42. By careful enclosure positioning, such air gaps can be transformed into effective crumple zones on deployment of the enclosures, optimising energy dissipation and controlling engine to bulkhead kinematics. As shown in Figure 10, the deployed enclosures can further provide additional support to the structural members for example by supporting the bumper cross member by coupling it to the engine.

An twelfth embodiment of the present invention is shown in Figures 12a and 12b. In this embodiment, the enclosure 1 is

used as an emergency flow restriction in a pipe 32. Figure 11a shows a pipe 32 in cross-section with an undeployed enclosure 1 conforming closely to the interior wall of the pipe along half the circumference thereof. A propellant 4 is provided within the enclosure which can be activated via an initiator 33.

In an emergency situation, the pipe's flow can be severely restricted, even stopped, by activation of the enclosure as shown in Figure 12b.

Figures 13a and 13b illustrate a thirteenth embodiment of the present invention. In this embodiment, the enclosure is used within a disconnect apparatus, such as for a car battery in the event of an accident. As shown in Figure 12a electrical connection is made between points A and B through the walls of enclosure 1 and contact 34. The enclosure 1 and contact 34 may be held together by way of a retention clip or stud 35. If an accident is sensed, squib initiator 33 activates propellant 4 to expand the enclosure according to Figure 12b. A consequence of this is that the connection between the enclosure and contact 34 is broken. Such a disconnection switch can be used in any environment where a permanent, reliable and rapid (1ms) disconnection is required.

In a fourteenth embodiment, the enclosure is used to provide an instant beam structure as shown in Figures 14a and 14b. The undeployed enclosure of Figure 13a comprises two relatively thick walled sheets 48 joined together by two folded relatively thin sheets 49 in the form of a flat package suitable for transportation. On inflation of the enclosure 1 the sheets 48 are pushed apart to form a beam. The beam thus formed has a significantly enhanced bending

strength which can be deployed at a split seconds notice. Such a beam structure is envisaged for use in for example instant bridges or temporary housing structures.

In a fifteenth embodiment of the present invention, the enclosure takes the form of a test rig simulation aid. In particular, as shown in Figures 15a and 15b, a matrix of enclosures 1 is provided within the floorpan 36 and toeboard 37 structure of a vehicle. A crash dummies leg 38 is set up to be monitored using conventional sensing apparatus.

In order to simulate the effects of an accident, in the present example in respect of a toeboard intrusion, the enclosures 1 are triggered to inflate thereby representing vehicle crash behaviour as shown in Figure 15b at 30ms after inflation. The enclosures 1 can be actuated independently to most accurately replicate the likely deformation in the event of different impact circumstances. The enclosures could also be used on a car body sled where there is only a simulated impact but that requires simulation of body intrusion into the passenger compartment. Since the vehicle itself is not moving, the process of monitoring the deformation is significantly easier to set up and control. Readings are thereby more likely to be accurate. Further, use of the enclosures as a simulation aid represents a substantial cost saving compared with conventional test method involving crash testing real vehicle structures in moving test rigs.

As a variation on the arrangement of the embodiment of Figures 15a and 15b, the enclosure 1 could be used in a production vehicle as shown in Figures 15c and 15d to move the lower leg away from the risk of injury by deploying the enclosure in the event of a crash.

In a sixteenth embodiment of the present invention, the enclosure can be used as a floatation device as illustrated in Figures 16a and 16b.

In Figure 16a, an enclosure 1 is positioned within for example the hull of a boat 31. In an emergency situation, e.g. a capsize or a rapid flooding, the enclosure can be activated to inflate as shown in Figure 16b, either manually or by way of orientation or water level sensors. The inflated enclosure will afford a level of buoyancy relative to the deployed volume thereof.

Figures 17a to 26 show enclosures with various venting configurations. The act of venting is involved in the dissipation of energy during deformation of the enclosure. The vented gases may be dispelled through the walls of the enclosure (if a permeable material) or through discrete vent holes. The use of discrete venting allows for many configurations of design, illustrated in the following embodiments.

The enclosure of Figures 17a and 17b has a simple vent 60 as shown. The squib/initiator 61 and pyrotechnic charge 62 would normally be encapsulated in a suitable material to prevent the exposure to moisture.

The enclosure of Figures 18a and 18b has a vent 60 sealed with a cap of foil 63, or similar material. On deployment the enclosure 1 starts to deform as the pressure within the enclosure rises. Once the pressure reaches a certain limit the foil opens and the enclosure begins to vent. The foil may be attached to the enclosure using various adherent bonding or mechanical interface techniques.

In the enclosure of Figures 19a and 19b, the perimeter bonding 64 is interrupted as shown to produce vent 60. On deployment the inflation gases are able to vent through the un-bonded perimeter of the enclosure, so providing the necessary venting.

The enclosure of Figures 20a and 20b is designed to have a reduced strength zone 65 which, at a pre-determined pressure, is able to deform, creating an opening for gas venting.

In Figures 21a and 21b, the enclosure 1 is designed with a pipe 66 attached, through which the gases can vent out of the enclosure. This allows for the positioning of the enclosure in heat sensitive zones, the gases being ported away from the vehicle interior. The open end 67 of the vent pipe 66 may or may not be sealed with a foil type component.

The enclosure of Figures 22a and 22b is designed with a protrusion 68 on one of the enclosure walls which, in the undeployed state, fits into a hole 69, on the other wall of the enclosure. When deployed the enclosure starts to deform and, hence, opens the vent hole, so permitting gas venting.

Figure 23 shows an enclosure 1 designed in a complicated configuration. When triggered the gas must travel through a non-direct or serpentine route to the external vent, thus delaying the time of venting.

The pyrotechnic charge would normally be positioned toward the centre of the enclosure to allow symmetrical deployments. Positioning of the pyrotechnic charges in alternative positions could allow for non-symmetrical deployments and deformations of the enclosure, where this is desirous.

Normally, the pyrotechnic charge should be protected from adverse environments such as moisture. This can be achieved by sealing the enclosure to the atmosphere or by protecting the pyrotechnics in an air tight membrane/substrate. Use of pyrotechnics which are unaffected by the environment would negate the need to seal the enclosures.

The placement of the pyrotechnics would also be affected by the type of generant used and the burn mechanisms employed. For example, sodium azide type generants have different mass flow characteristics dependant on the pressure in which the gas is being generated. One may chose to position the propellant in a restricted part of the enclosure to exploit the differing mass flow characteristics.

Certain generants rely on enclosure pressure to combust efficiently. It is also important to hold the generant material in close proximity during combustion. As shown in Figure 24, a gas generant 91 is held within a small volume formed within the enclosure 1 using a pyro chamber seal or a diffuser plate 90. An initiator charge 92 is located close to the squib 61. When triggered, the squib ignites the initiator charge which, in turn, burns the gas generant charge. Gas then flows, or burst, through the diffuser plate or pyro chamber seal respectively. The enclosure is thus inflated. In such an arrangement, the burning of the gas generant is improved by use of an initiator charge to provide a sustained ignition of the gas generant. Back pressure within the small volume caused by restricted flow to the main enclosure volume gas the diffuser plate. As shown in Figure 25, the gas generant is held within a peripheral wall 95. The generant is therefore held together for the first milliseconds of activation to assist the burning process.

Further, as shown in Figure 26, the gas generant is encapsulated in a material 96 which holds the generant material in close proximity and so aids the burning process.

The generant should normally be restrained within the enclosure to prevent movement during impacts/vibration.

With the enclosures discussed above, integral inflators may take the form of industry pyrotechnics such as arcite, sodium azide technology, or a mix of $NaN_3$, $KNO_3$, and $S_1O_2$.

It will be understood that the embodiments illustrated show certain applications of the invention only for the purposes of illustration. In practice the invention may be applied to many different configurations, the detailed embodiments being straightforward for those skilled in the art to implement.

For example, the walls of the enclosure are formed of self supporting material. Whilst such material may be metal, other suitable alternatives may be plastics, wood/paper derived materials or a hybrid.

It will be further appreciated that the deployment timing and energy dissipation characteristics of the enclosure can be varied and controlled by changing one or more of: the enclosure material, the enclosure material thickness, the enclosure vent configuration (position and/or dimensions), the generant quantity, the generant characteristics (burn rate, surface area, chemical composition, etc) and the enclosure dimensions.

Further applications of the present invention enclosure may be in crash helmets, roadside hardware such as lamp posts and

roadside crash barriers, car bumpers, inflatable A,B and C pillars within vehicle interiors, inflatable backs to rear car seats to attenuate load and to prevent luggage intruding into the passenger compartment, inflatable dash board car trims affording knee protection, and inflatable sun visors for head protection.

CLAIMS:

1. An inflatable assembly for use in impact protection, the assembly comprising:-

a deformable enclosure having provided therein a gas generant;

wherein the enclosure is formed of material whereby it retains a deformed configuration following activation of the generant.

2. An inflatable assembly according to claim 1, wherein the enclosure comprises said gas generant, sandwiched between a pair of deformable sheets, the enclosure having a substantially flat laminar configuration in an uninflated state.

3. An inflatable assembly according to claim 1 or 2, wherein the enclosure is provided with one or more vents.

4. An inflatable assembly according to any preceding claim, wherein one or more of said enclosures are positioned in the side structure of a vehicle, the one or more enclosures being arranged on deployment to expand generally outwardly, away from the interior of the vehicle.

5. An inflatable assembly according to any preceding claim, wherein one or more of said enclosures are positioned within the side structure of a vehicle, level with the area of the pelvis of any occupant within the vehicle.

6. An inflatable assembly according to any preceding claim, wherein one or more of said enclosures are positioned within the side structure of a vehicle, level with the area of the

shoulder of any occupant within the vehicle.

7. An inflatable assembly according to any one of claims 1 to 3, wherein one or more of said enclosures are provided between a cross car beam or vehicle structure and a steering column of a vehicle.

8. An inflatable assembly according to any one of claims 1 to 3, wherein one or more of said enclosures are provided within the lower seat structure of a vehicle, below an occupant's thigh area.

9. An inflatable assembly according to any one of claims 1 to 3, wherein one or more of said enclosures are provided within or adjacent the bonnet structure of a vehicle.

10. An inflatable assembly according to any one of claims 1 to 3 wherein one or more of said enclosures are provided on a vehicle trim at or adjacent to the knee area of an occupant.

11. An inflatable assembly according to claim 10, wherein the enclosure is configured to expand both towards the occupant and towards the vehicle bulkhead/instrument panel.

12. An inflatable assembly according to any one of claims 1 to 3, wherein one or more of said enclosures are provided with vents for supplying inflation gases to an associated flexible walled chamber.

13. An inflatable assembly according to any one of claims 1 to 3, wherein one or more of said enclosures are provided within an aircraft bulkhead structure.

14. An inflatable assembly according to any one of claims 1 to 3, wherein one or more of said enclosures are provided within the roof or upper body structure of a vehicle.

15. An inflatable assembly according to any one of claims 1 to 3, wherein one or more of said enclosures are provided in the floor pan structure of a vehicle at or adjacent an occupant's foot area.

16. An inflatable assembly according to any one of claims 1 to 3, wherein one or more of said enclosures are provided within a rim structure of a vehicle steering wheel.

17. An inflatable assembly according to any one of claims 1 to 3, wherein one or more of said enclosures are provided within an engine compartment of a vehicle.

18. An inflatable assembly according to any one of claims 1 to 3, wherein one or more of said enclosures are provided as a shut off valve within a conduit.

19. An inflatable assembly according to any one of claims 1 to 3, wherein one or more of said enclosures are provided as an electrical cut-off switch.

20. An inflatable assembly according to any one of claims 1 to 3, wherein one or more of said enclosures are provided as inflatable load bearing beam structures.

21. An inflatable assembly according to any one of claims 1 to 3, wherein one or more of said enclosures are provided as deformation simulation means within a static or dynamic crash simulation rig.

22. An inflatable assembly according to claim 1 or 2, wherein one or more of said enclosures are provided as an inflatable buoyancy means.

23. An inflatable assembly for use in impact protection, the assembly comprising:-

a deformable enclosure;

means for inflating the enclosure to deform it;

wherein the material of the enclosure is such as to retain an inflated configuration following its inflation, and further wherein the enclosure is provided with one or more vents for enhancing deformation of the inflated enclosure.

24. An inflatable assembly for use in impact protection, the assembly comprising:-

a deformable enclosure;

means for inflating the enclosure to deform it;

wherein the enclosure is positioned within the side structure of a vehicle, level specifically with the area of the pelvis of an occupant within the vehicle.

25. An inflatable assembly according to claim 3 or 24, wherein the one or more vents are provided with a pressure sensitive valve.

26. An inflatable assembly according to claim 3 or 24, wherein the one or more vents are formed as discontinuities in the seal or join between component parts of the enclosure.

27. An inflatable assembly according to claim 3 or 24, wherein the one or more vents comprise frangible sections of the enclosure.

28. An inflatable assembly according to claim 3 or 24, wherein the one or more vents comprises ducting to remove generant gases from the locality of the enclosure.

29. An inflatable assembly according to claim 3 or 24, wherein the one or more vents is plugged, in an undeployed state of the enclosure, by a component of the enclosure which on deployment of the enclosure is urged from the vent to allow venting.

30. An inflatable assembly according to any preceding claim wherein the undeployed enclosure has a serpentine configuration.

31. An inflatable assembly according to any proceeding claim wherein the enclosure is configured to concentrate a gas generant in the vicinity of an ignition means.

32. An inflatable assembly substantially as hereinbefore described with reference to the accompanying drawings.

FIGURE 1A

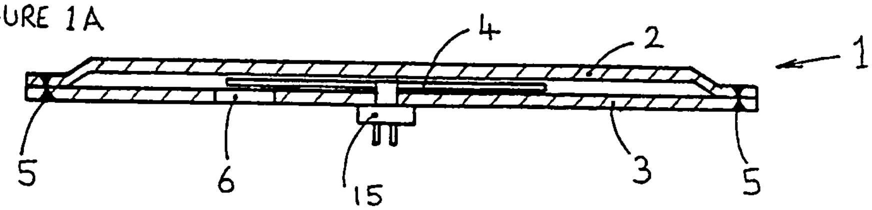



FIGURE 1B

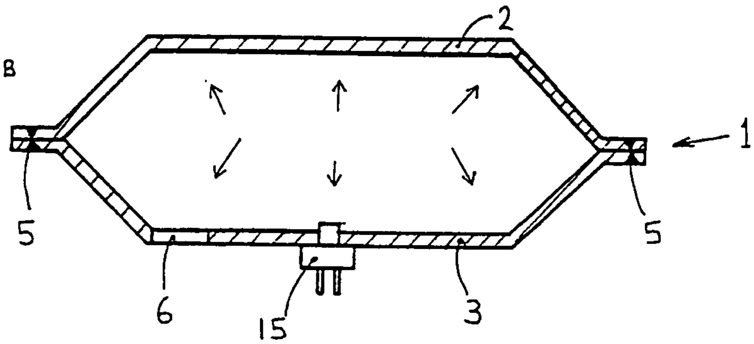



FIGURE 2A

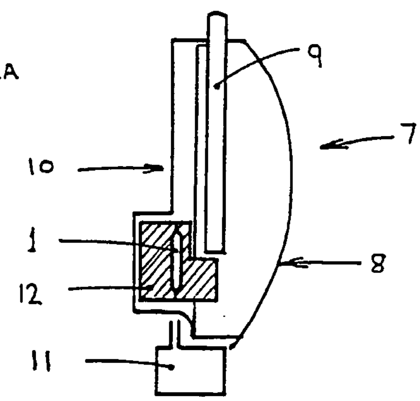



FIGURE 2B

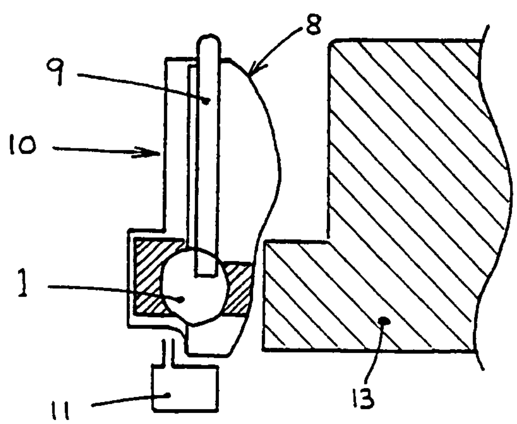


FIGURE 3A

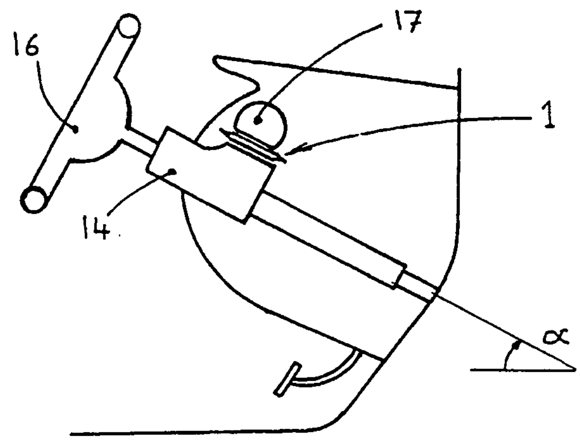
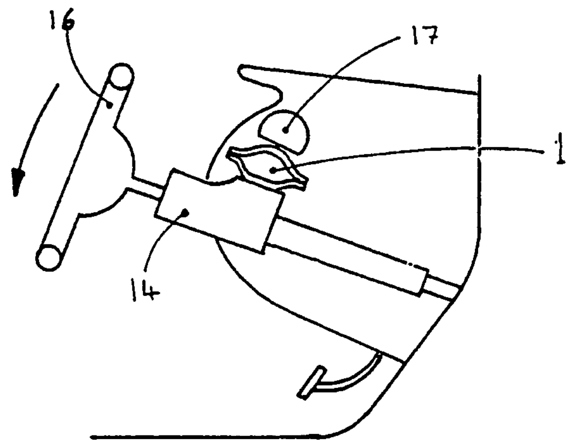



FIGURE 3B



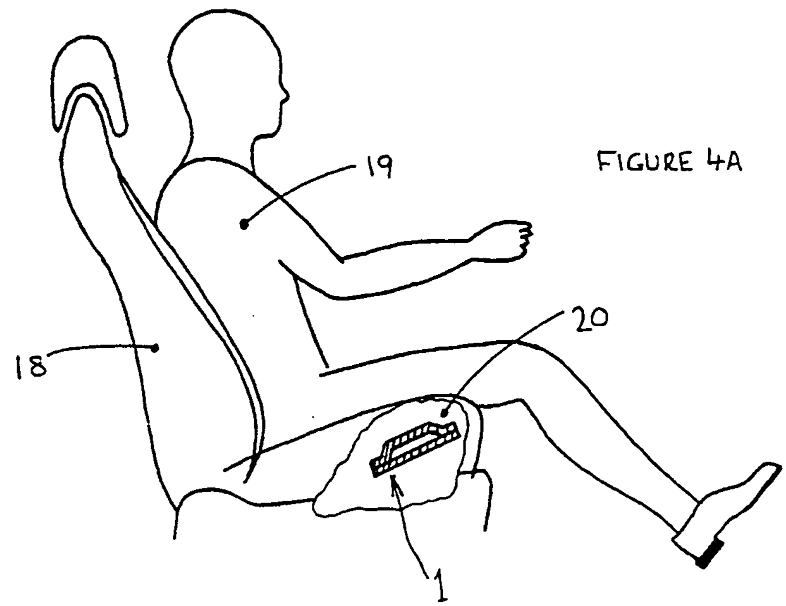



FIGURE 4A

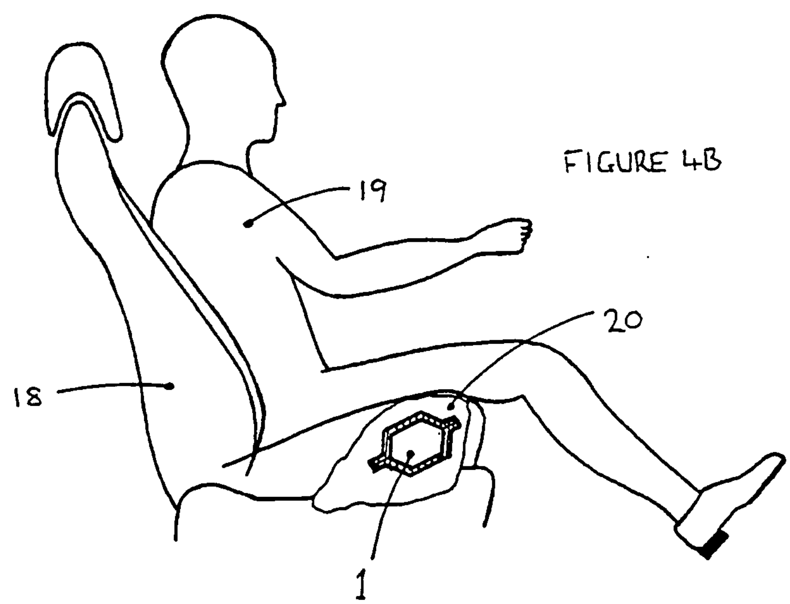



FIGURE 4B

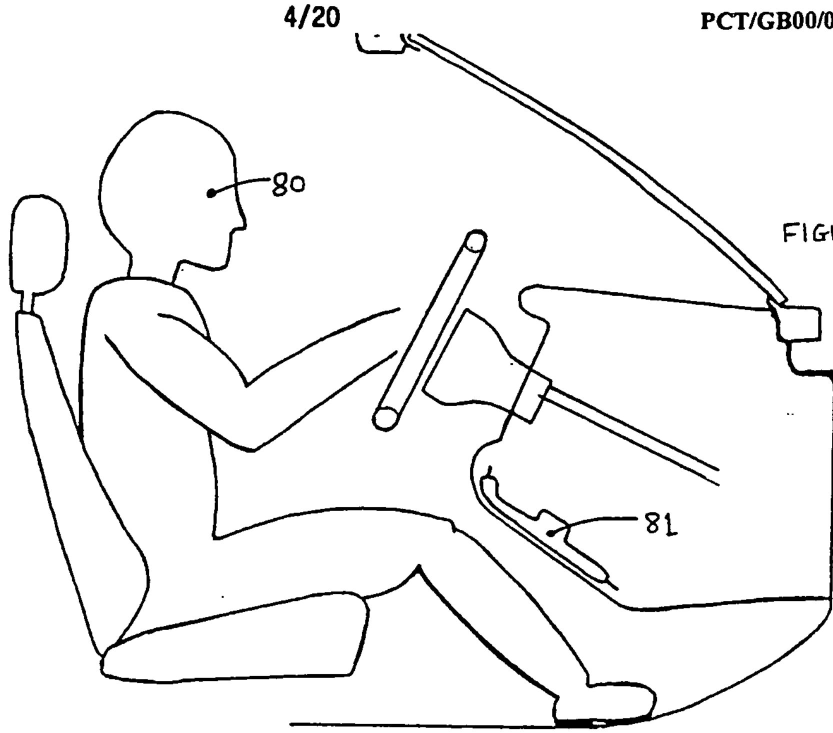



FIGURE 5A

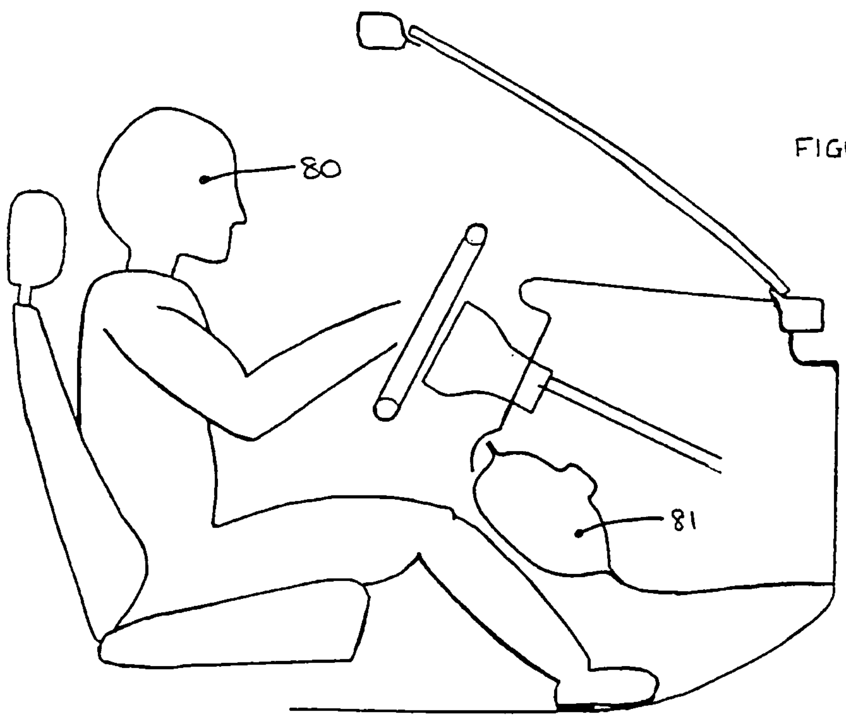



FIGURE 5B

FIGURE 6A

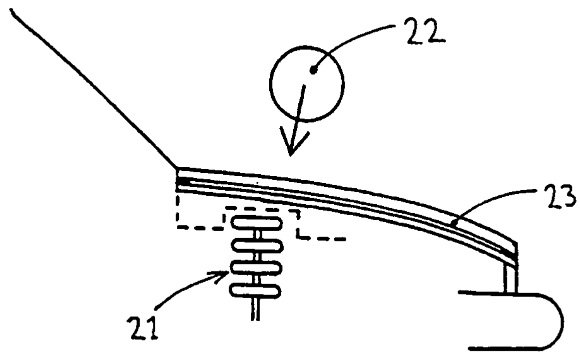



FIGURE 6B

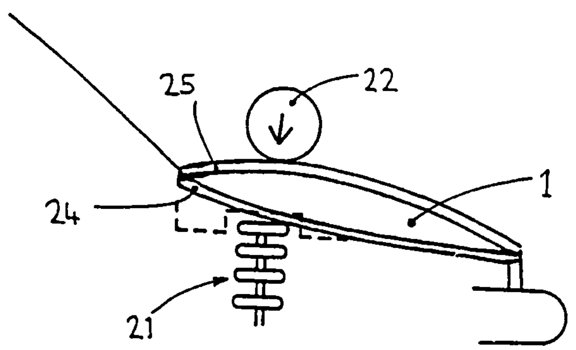


FIGURE 7B

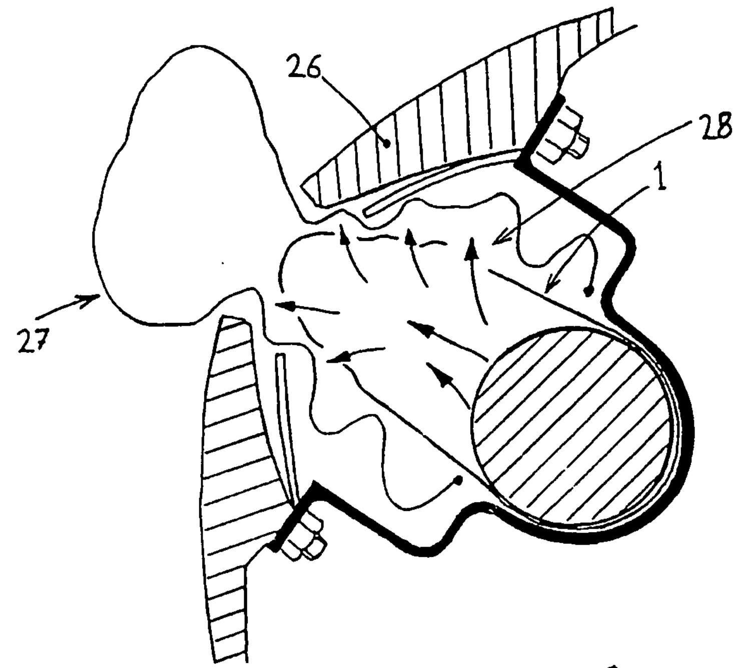



FIGURE 7A

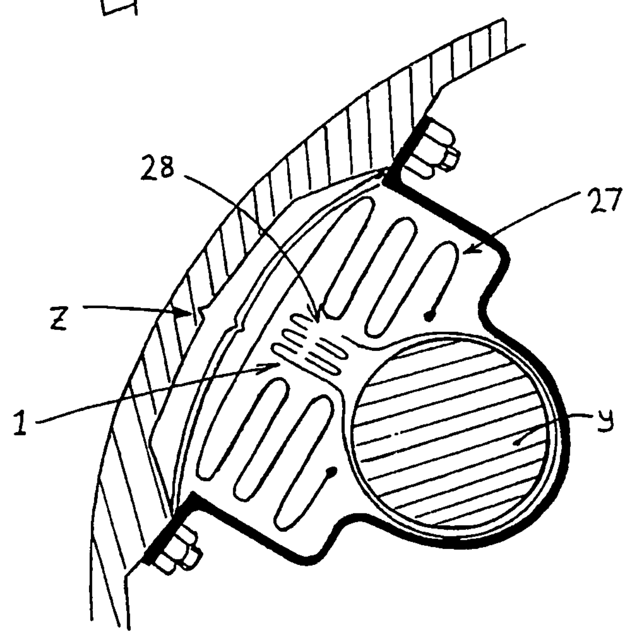


FIGURE 8

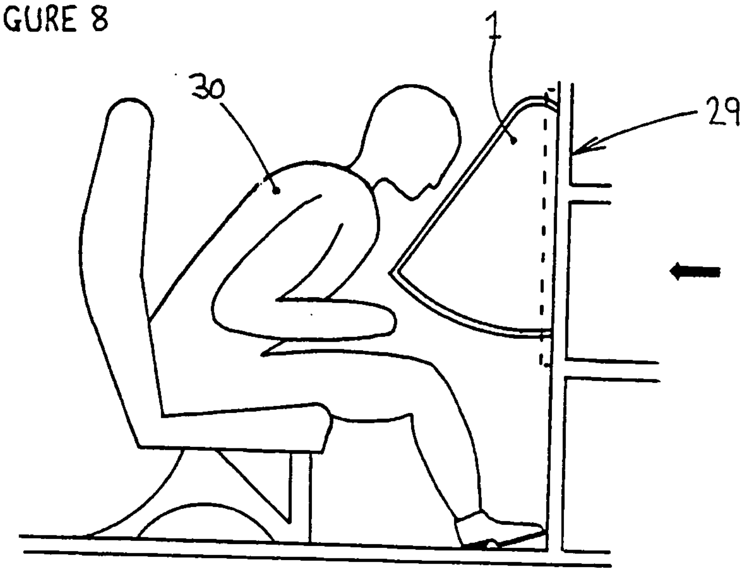



FIGURE 9

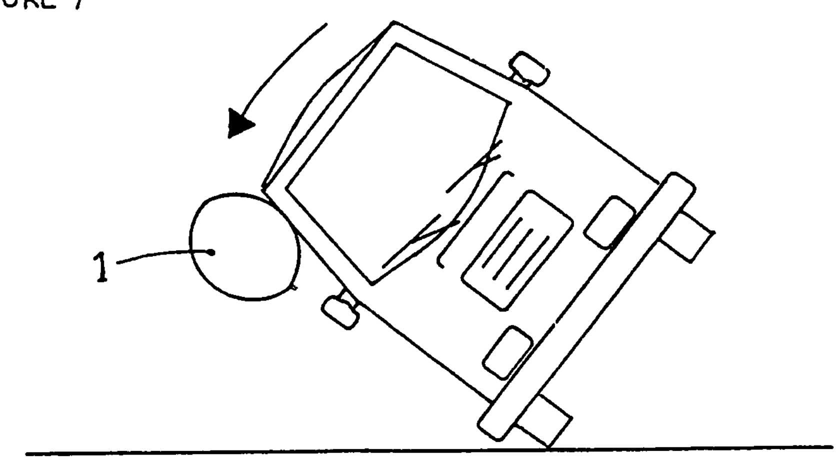


FIGURE 11

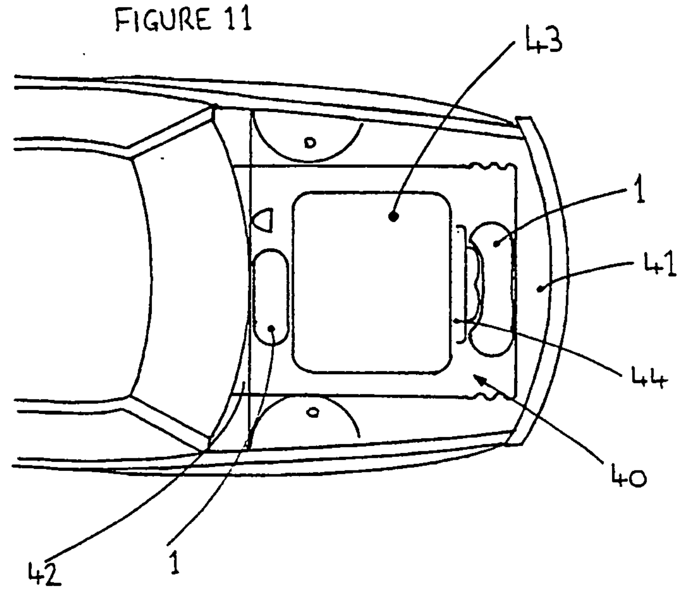



FIGURE 10A

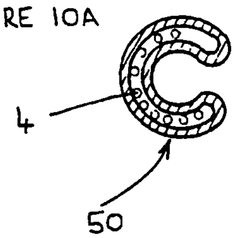



FIGURE 10B

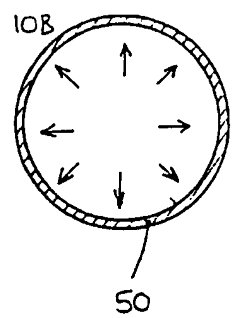


FIGURE 12A

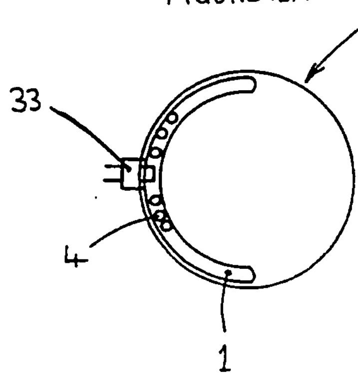
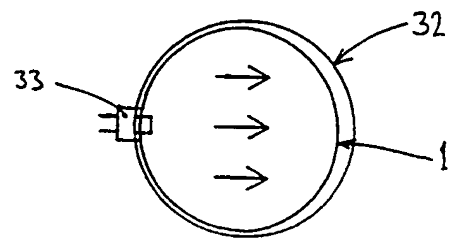



FIGURE 12B



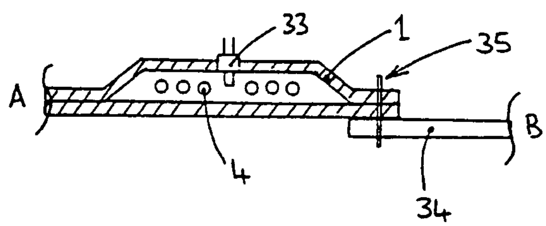




FIGURE 13A

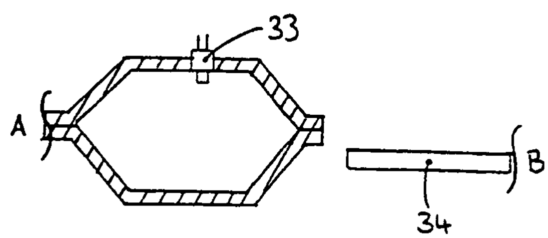



FIGURE 13B

Figure 14a

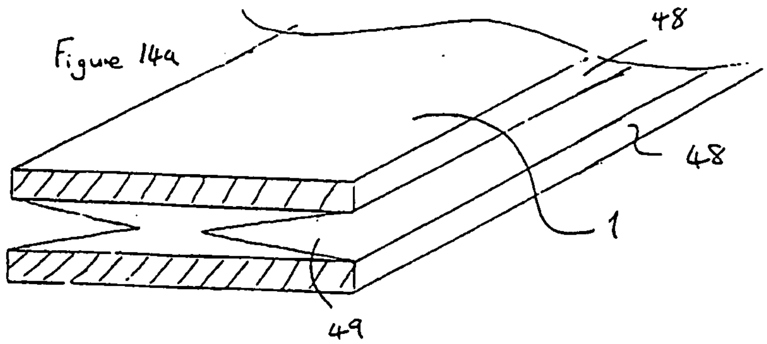
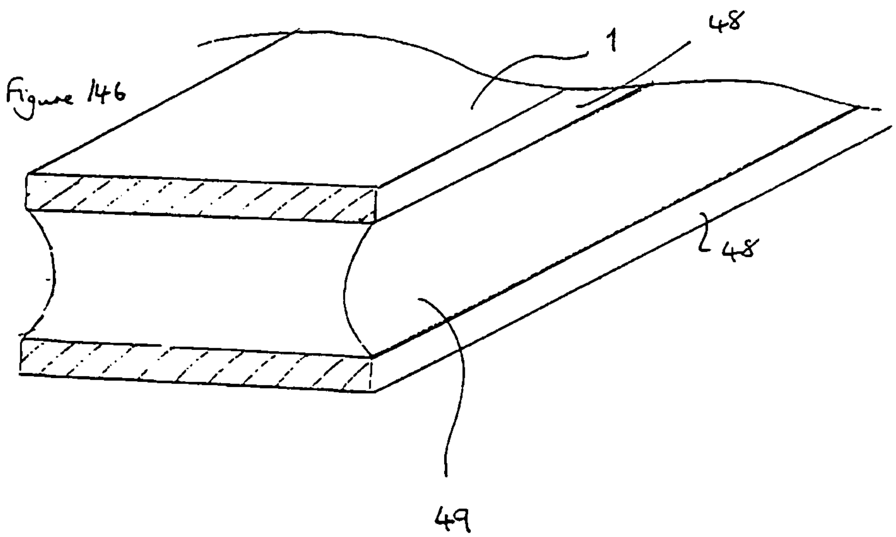



Figure 14b



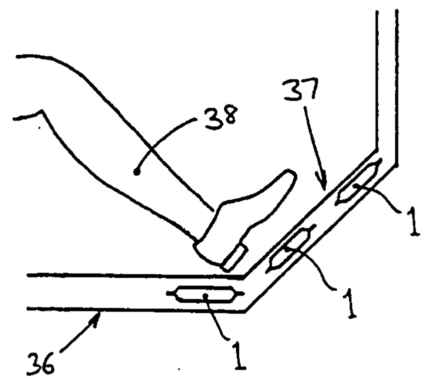



FIGURE 15A

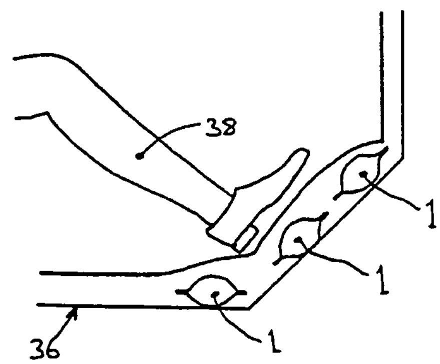



FIGURE 15B

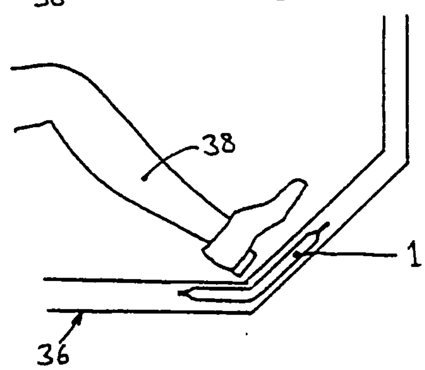



FIGURE 15C

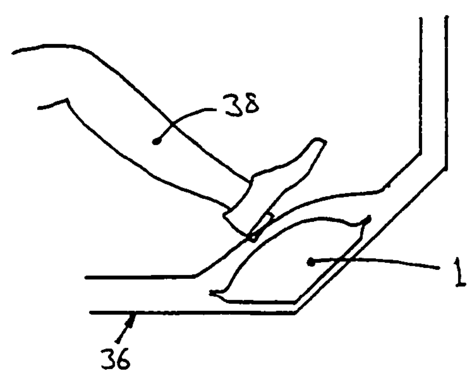



FIGURE 15D

FIGURE 16A

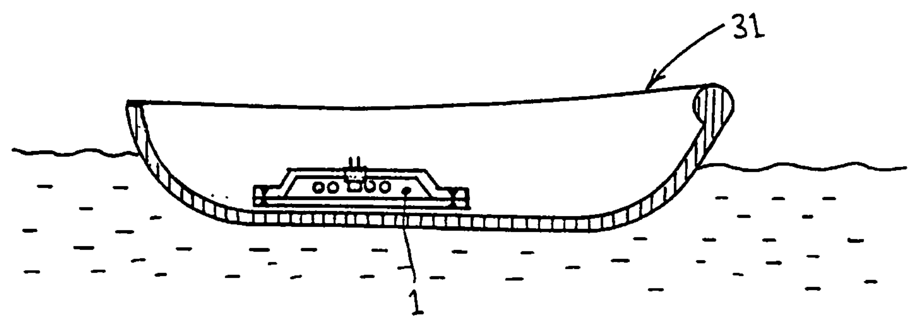



FIGURE 16B

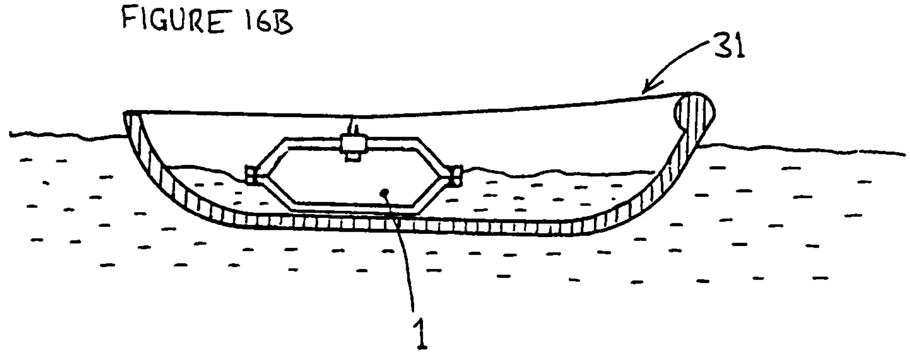


Figure 17a

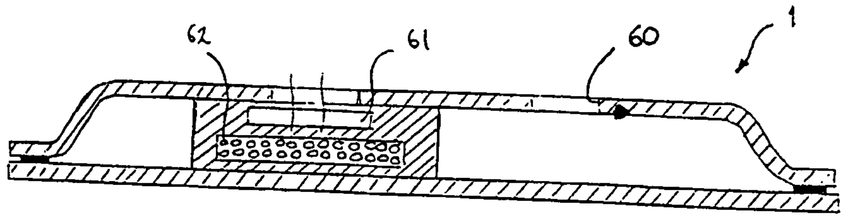



Figure 17b

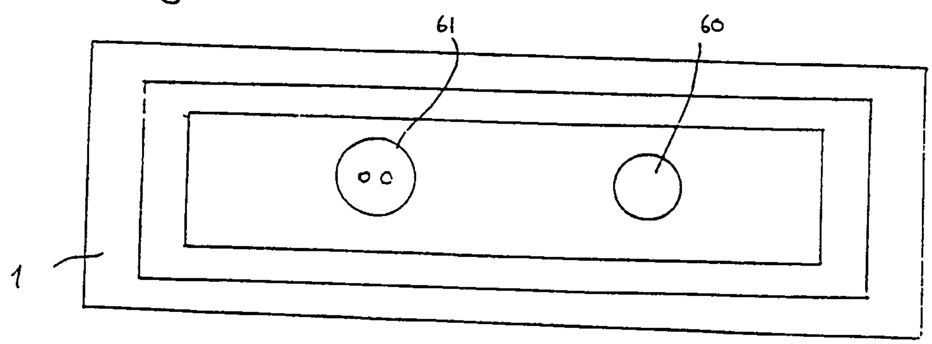


Figure 18a

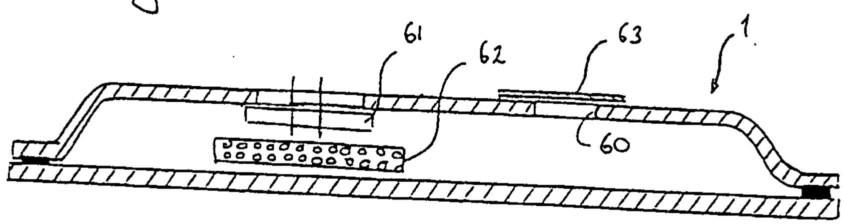



Figure 18b

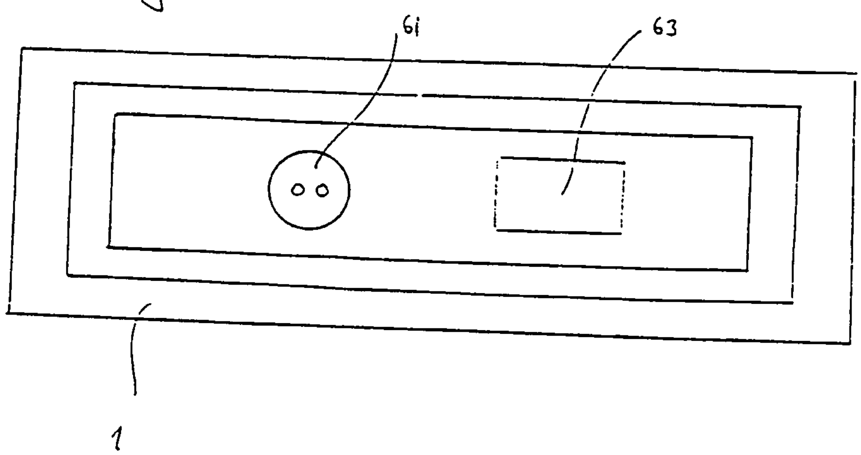


Figure 19a

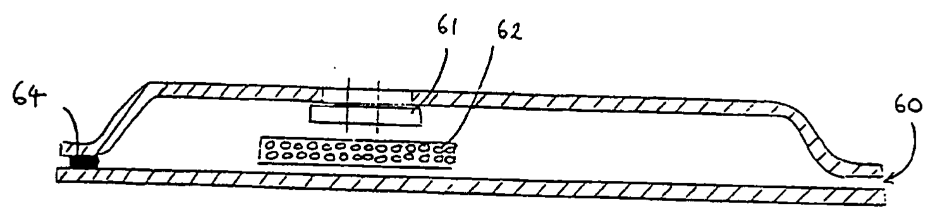



Figure 19b

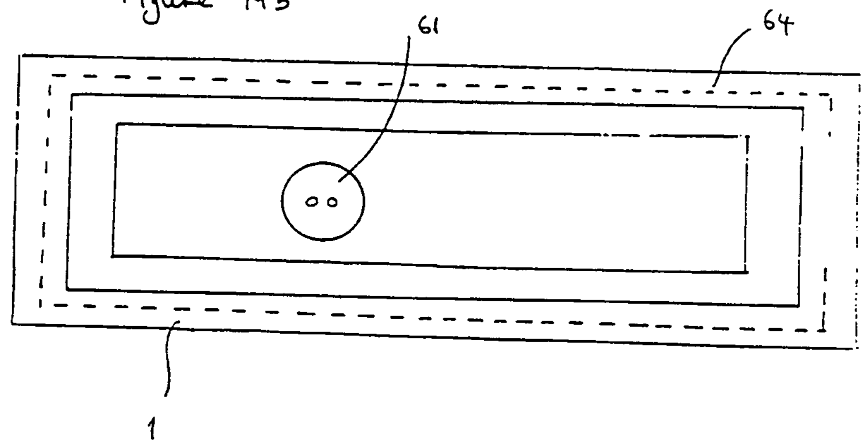


figure 20a

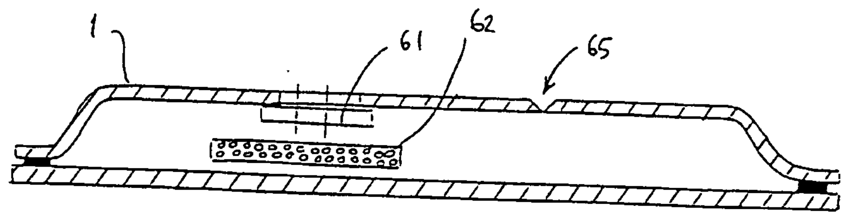



figure 20b

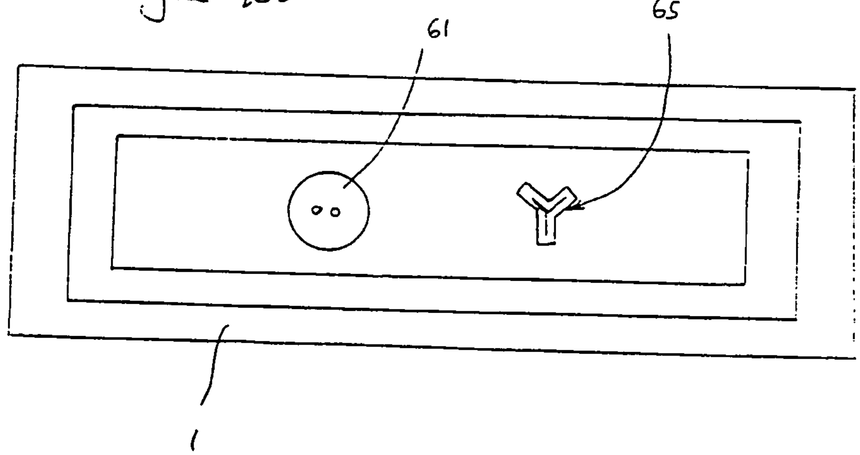


Figure 21 a

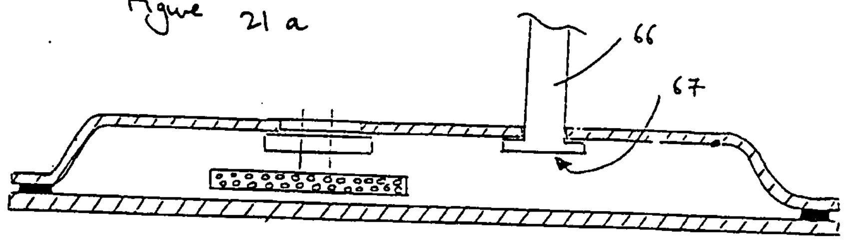



Figure 21 b

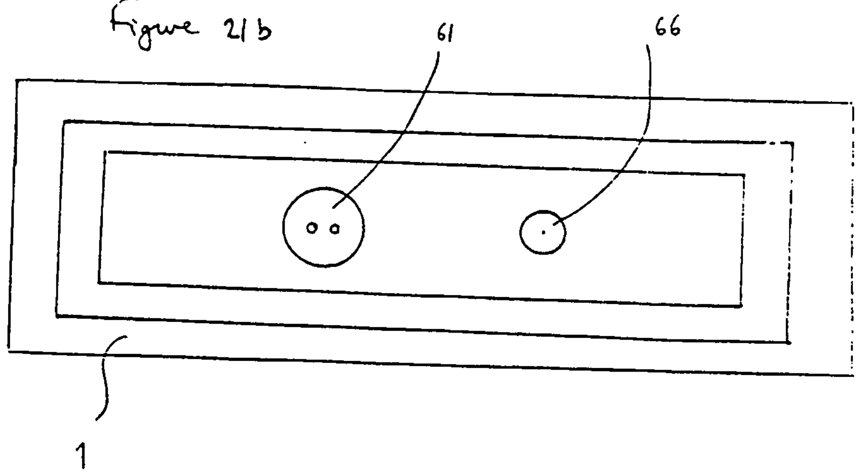


Figure 22a

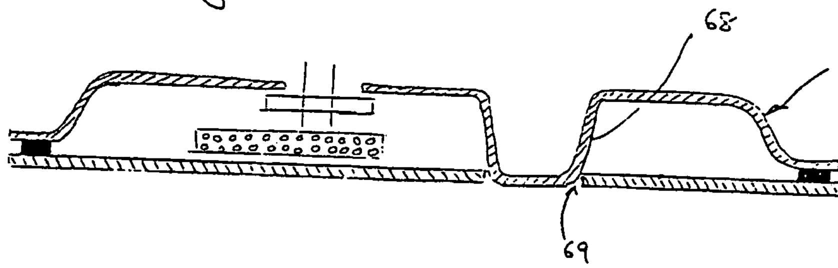
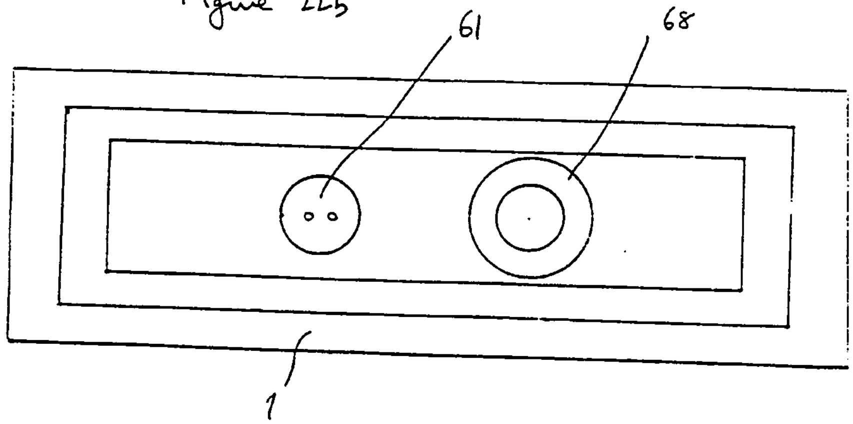



Figure 22b



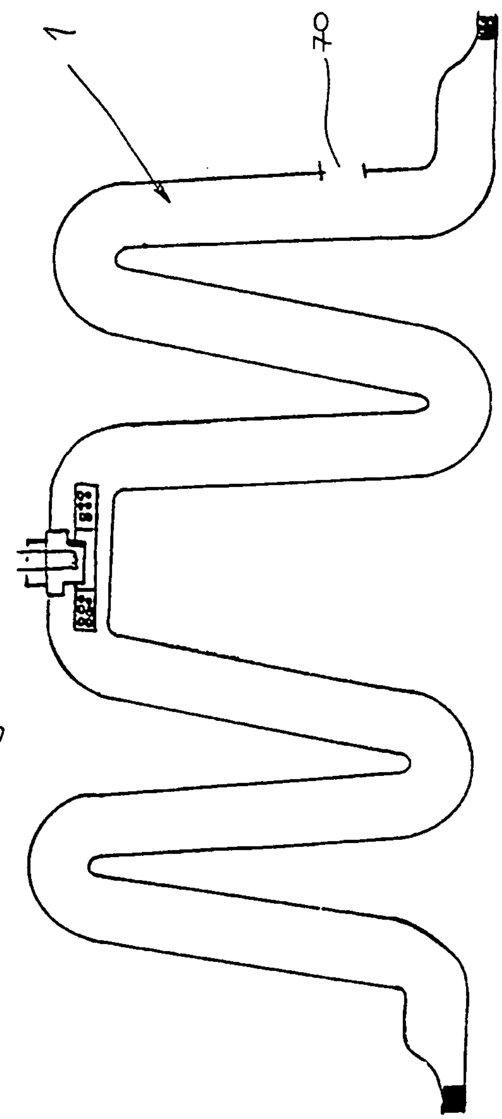



Figure 23

FIGURE 24

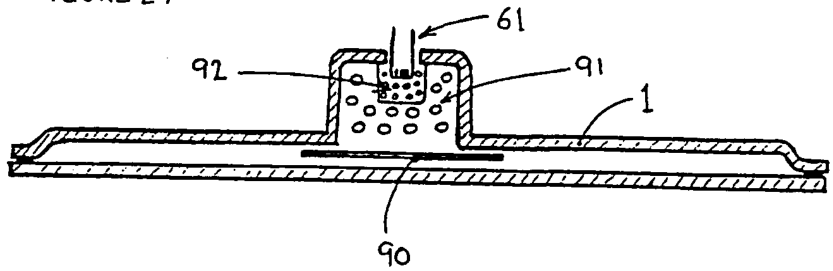



FIGURE 25

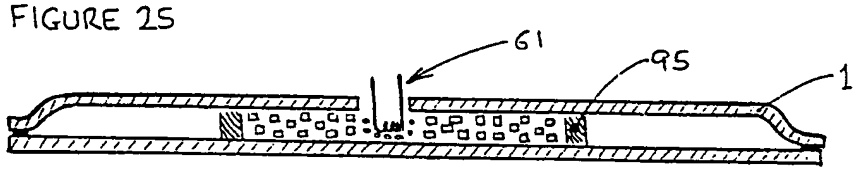
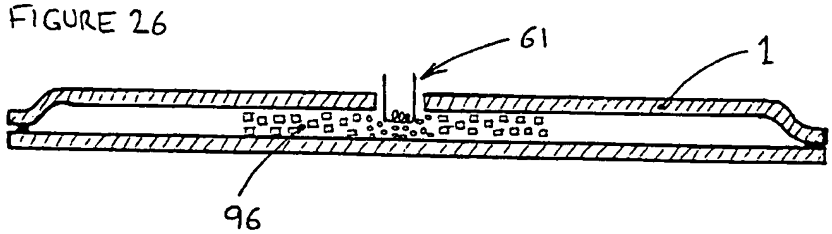



FIGURE 26



# INTERNATIONAL SEARCH REPORT

Internati . Application No
PCT/GB 00/00647

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 7 B60R21/16 B60R21/34

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| X | US 4 050 537 A (BEZ ULRICH) 27 September 1977 (1977-09-27) column 1, line 5 - line 8 column 2, line 23 -column 3, line 16 figures 1-3 | 1,2,9, 17,32 |
| Y | | 3,4,14, 15,20, 23,25 |
| A | | 31 |
| Y | DE 195 46 332 A (RENNET ANDREAS DIPL ING) 28 August 1997 (1997-08-28) column 1, line 3 - line 33 column 2, line 15 -column 3, line 48 figures | 3,4,14, 15,20, 23,25 |
| A | | 1,2,7,9, 11,17,29 |

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 9 June 2000 | 16/06/2000 |

| Name and mailing address of the ISA | Authorized officer |
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| European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016 | Peltz, P |

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# INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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